From: Brittain Hill
To: "Cynthia L. Dinwiddie" <CDINWIDDIE@cnwra.swri.edu>,"Donald Hooper" <DHOOPER@cnwra.swri.edu>,"Nancy Adams" <"nadams@cnwra.swri.edu".NRGWIA01.NRGWDO01@cnwra.swri.edu>
Date: 9/7/2006 7:45:35 AM
Subject: Re: truncation of cooling joints
cc: "Ronald McGinnis" <RMCGINNIS@cnwra.swri.edu>

Cooling joints in ignimbrites can well be a multistage process, with early and late-formed joints possible. If a unit is nonwelded, it can still be indurated by devitrification processes (crystallize the glass into quartz+Kspar etc.) that occur during late-stage cooling and degassing. As long as it's stuck together, it can break.

I think of such joints as simple shrinkage cracks. If the iggy is emplaced hot (e.g., 500C) then amount of shrinkage in rock from thermal contraction is relatively large and it's easier to get fractures developed when tensile stress exceeds the local strength of the rock. Joints are predominantly vertical because lithostatic load results in a deviatoric stress that gives easiest strain on vertical planes.

In cooler parts of the iggy (~200C or so), you're well below the glass annealing/deformation temperature, but still hot enough for vapor-phase devitrification reactions to occur. As this somewhat indurated mass contracts to ambient temperatures, there still will be thermal contraction and resulting strains, just not as prevalent as in the more intensely welded (and fractured) part of the ig.

Since changes in temperature are usually gradational in larger iggys (e.g., a single cooling unit), this transition from welded to less welded to nonwelded may extend for meters of depth. Such simple thermal gradients could well result in a continuum of fracturing, albeit with a overall decrease in fracture abundance with decrease in initial emplacement temperature.

A common observation is that welded interiors have pseudo-columnar joint patterns, that diffuse to coarse blocky joints as you move downward towards the nonwelded base of the iggy. These broad joints then tip-out when you're in the weakly indurated to nondevitrified part of the ig.

If there are significant gaps between emplacement of multiple flow lobes, this pattern may be more chaotic as multiple thermal gradients will form. But I think the Bishop was a simple cooling unit, even though there were multiple flow lobes.

Bottom line: late-stage devitrification also can make an iggy sufficiently indurated so that brittle strain will occur in combination with thermal contraction and lithostatic load. Although magnitude and extent of fractures in devitrified tuff are usually less than in welded tuff, fracturing process is not restricted to welded

zones.

Britt

>>> "Cynthia L. Dinwiddie" <cdinwiddie@cnwra.swri.edu> 9/6/2006 4:31:03 PM >>>

Hi Volcanologists, Can you help me out here… We see cooling joints exposed at the surface of the Bishop Tuff in a unit that is moderately welded. Is there any chance cooling joints in a moderately welded unit could extend into the unit below, which is characterized as “slightly welded, sintered, and intensely fractured”? The unit below the sintered/slightly welded unit is characterized as nonwelded to poorly welded. In a poorly welded unit, can you have cooling joints? I’m fairly certain you can’t have cooling joints in nonwelded tuff because the tuff is relatively cool when deposited, but I’m unsure about the transitional zones in-between. Thanks in advance! Cynthia L. Dinwiddie, Ph.D., P.G.Senior Research Engineer/Hydrogeologist
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Subject: Re: truncation of cooling joints
Creation Date: 9/7/2006 7:45:35 AM
From: Brittain Hill

Created By: BEH1@nrc.gov

Recipients
"Ronald McGinnis" <RMCGINNIS@cnwra.swri.edu>
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"Donald Hooper" <DHOOPER@cnwra.swri.edu>
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Files	Size	Date & Time
MESSAGE	3649	9/7/2006 7:45:35 AM
TEXT.htm	9602	3/12/2008 10:01:33 AM

Options
Priority: Standard
Reply Requested: No
Return Notification: None
None

Concealed Subject: No
Security: Standard

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